RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision A

Meeting #9

1090 MOPS and DF=19

Initiated by Jerry Anderson
Presented by Gary Furr

SUMMARY
DF=19 is only is only used for military use and there should be no requirements in DO-260 relative to DF=19. All references to DF=19 should be removed.

Background:

Once upon a time the draft 1090 MHz MOPS had been reviewed by the RTCA SC-186 Plenary in June 2000. BUT, after that review, Table 2-2 (inside Section 2.2.3.2.1) was revised to include descriptions of the ADS-B Message Baseline Format Structure for DF=19.

Sections 2.2.3.2.1.1.3, 2.2.3.2.1.1.4 and 2.2.3.2.1.1.5 and Table 2-10 were revised to include information on DF=19. Additionally, section 2.2.4.3.4.7.3 (page 116) was updated with DF=19 information, as was all of the Section 2.4 subsections associated with the corresponding 2.2 sections.

Now, The Problem:

Toward the end of November, Jerry Anderson asked the question of Vince Orlando:

"DO-260 says DF=17 is for transponder-based ADS-B systems and DF=18 is for non-transponder-based systems. What do we say for DF=19? Is it important to say they are, or are not, transponder-based? Is AF=0 transponder-based? Should TCAS attempt to interrogate/acquire a DF=19, if AF=0?"

To which Vince Orlando relied that:

"DF=19 is intended for military use only. There is no reason for TCAS to monitor DF=19. If military aircraft participate in extended squitter, they will use DF=17."

Which produced only more questions from Jerry Anderson:

"If DF=19 is 'reserved for military use only' as stated in the Note at the end of Note 4 of Figure 2-2 (page 34), why does paragraph 2.2.4.3.4.7.3.a (page 116) say, 'The ADS-B transmission shall be accepted as a valid ADS-B Message if: a. The first five bits of the data block contain either … DF=17, DF=18, or DF=19'? We should not have a requirement to receive military only transmissions.

Why does Figure 2-2 and Table 2-10 indicate that AF=0 is for the 'ADS-B message structure'? We should not place requirements on the military only systems.

I think someone believes AF=0 is a way to allow DF=19 to be used by civilians. If this is correct, I think we need to say that this DF=19 ism or is not, part of a Mode S transponder."

Finally, A Proposal:

Jerry proposes that we delete the third row of Figure 2-2. Delete the reference to Note 4 and delete Note 4. In Table 2-10, change "ADS-B Message Structure" to "Reserved." Do a search and delete all other AF and DF=19 text from the rest of the document.

ADS-B MESSAGE BASELINE FORMAT STRUCTURES					
BIT #	1 --- 5	6 - 8	9 ----------32	33 ----------88	89 ----------112
DF=17 FIELD NAME	DF [5]	CA [3]	AA [24]	ME [56]	PI [24]
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB
DF=18 FIELD NAME	DF [5]	CF [3]	AA [24]	ME [56]	PI [24]
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB
DF=19 FIELD NAME	DF [5]	AF[4] [3]	AA [24]	ME [56]	PI [24]
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB
DF=19 FIELD NAME	DF [5]	AF[4] [3]	9 ---------- RESERVED FOR MILITARY APPLICATIONS [104] ----------112		
	MSB LSB	MSB LSB	MSB LSB		

Notes:

1. *"[#]" provided in the Field indicates the number of bits in the field.*
2. *"CA" field shown above is used in DF=17 messages, while "CF" is used for DF=18 messages.*
3. *DF=19 mesages are intended for Military Application systems only.*
4. *For DF=19, if the AF field is equal to 000 then bits 9-32 shall be used for the AA field, bits 33-88 shall be used for the ME field, and bits 89-112 shall be used for the PI field. If the AF field is equal to 001 - 111 then bits 9 - 112 shall be used for the "RESERVED FOR MILITARY APPLICATIONS" field (Note: this format is reserved for military use only.*

Figure 2-2: ADS-B Message Baseline Format Structure

2.2.3.2.1.1 ADS-B Message Baseline Field Descriptions

Baseline fields used in ADS-B Message transmissions are described in alphabetical order in the following subparagraphs.

2.2.3.2.1.1.1 "AA" Address Field, Announced

The "AA" field is a 24-bit (bits 9 through 32) field that shall contain the ICAO 24-bit Address of the transmitting installation in the clear. This provides unambiguous identification of the transmitting installation.

Note 1: *These requirements are consistent with the requirements of ICAO Annex 10, Volume IV, second edition, July 1998, section 3.1.2.5.2.2.2, as well as with the*

3. Because of the fact that it is important for fixed ground or tethered obstructions to report altitude, such objects shall always report the "Airborne" State.

d. Validation of Ground Status:

Note: *For aircraft with an automatic means of determining vertical status (i.e., weight-on-wheels, strut switch, etc.) the "CA" field reports whether the aircraft is airborne or on the ground. TCAS acquires aircraft using the short or long squitters, both of which contain the "CA" field. If an aircraft reports that it is on the ground, that aircraft will not be interrogated by TCAS in order to reduce unnecessary interrogation activity. The 1090 MHz ADS-B message formatter may have information available to validate that an aircraft reporting "on-the-ground" is actually on the surface.*

If the automatically determined Air/Ground status is not available or indicates that the Airborne Position Message (see section 2.2.3.2.3) shall be broadcast, then the Airborne Position Message shall be broadcast in accordance with subparagraph c.

If one of the conditions in Table 2-9B is satisfied, the Air/Ground status shall be changed to "Airborne" and the Airborne Position Message (see section 2.2.3.2.3) shall be broadcast irrespective of the automatically determined Air/Ground status.

Table 2-9B: Validation Of "ON-GROUND" Status

AIRBORNE POSITION MESSAGE BROADCAST						
ADS-B Emitter Category Set "A"						
Coding	**Meaning**	**Ground Speed**		**Airspeed**		**Radio Altitude**
0	No ADS-B Emitter Category Information	No Change to "On-the-Ground" status				
1	Light (<15,500 lbs.)	No Change to "On-the-Ground" status				
2	Small (15,500 to 75,000 lbs.)	> 100 knots	***or***	> 100 knots	***or***	> 50 feet
3	Large (75,000 to 300,000 lbs.)	> 100 knots	***or***	> 100 knots	***or***	> 50 feet
4	High-Vortex Large (aircraft such as B-757)	> 100 knots	***or***	> 100 knots	***or***	> 50 feet
5	Heavy (> 300,000 lbs.)	> 100 knots	***or***	> 100 knots	***or***	> 50 feet
6	High Performance (> 5g acceleration and >400 knots)	> 100 knots	***or***	> 100 knots	***or***	> 50 feet
7	Rotorcraft	No Change to "On-the-Ground" status				

2.2.3.2.1.1.3 "CF" and "AF", (used in DF=18 and DF=19)

The "CF" field of DF=18 messages is a 3-bit field (bits 6 through 8) used by Non-Transponder based installations. The "AF" ("Application Field") field of DF=19 messages is a 3-bit field (bits 6 through 8) used by all ADS-B Message transmissions from transmission devices that are Military Application based systems. Coding of the "CF" and "AF" field is specified in Table 2-10. Refer to section 2.2.3.2.1.1.2 for determining On Ground Status.

Table 2-10: "CF" and "AF" Field Code Definitions

Coding	DF=18 Meaning "CF" Field	DF=19 Meaning "AF" Field
0	ADS-B	ADS-B Message Structure
1 - 7	Reserved	Reserved for future Military Applications

2.2.3.2.1.1.4 "DF" Downlink Format Field

a. The "DF" field is the first field in all downlink formats and provides the transmission descriptor coded in accordance with RTCA Document DO-181B, Figure 2-5 (EUROCAE ED-73A, Figure 3-4).

b. The "DF" field shall be set to DF=17 (1 0001 binary) for all ADS-B Message transmission devices that are Mode-S transponder based systems.

c. The "DF" field shall be set to DF=18 (1 0010 binary) for all ADS-B Message transmissions from transmission devices that are not Mode-S transponder based systems.

d. The "DF" field shall be set to DF=19 (1 0011 binary) for all ADS-B Message transmissions from transmission devices that are Military Application based systems.

Note: *Encoding of the "DF" field is consistent with section 3.1.2.3.2 and Figure 3-8 in ICAO ANNEX 10, Volume IV, Second Edition, July 1998.*

2.2.3.2.1.1.5 "ME" Message, Extended Squitter

The "ME" field is a 56-bit (bits 33 through 88) downlink field used to transmit extended squitter Automatic Dependent Surveillance - Broadcast (ADS-B) and Aircraft Identification messages in DF = 17, DF = 18 and DF = 19 messages.

2.2.3.2.1.1.6 "PI" Parity / Identity

The "PI" field is a 24-bit (bits 89 through 112) downlink field that contains the parity overlaid on the Code Label ("CL") and Interrogator Code ("IC") fields, in accordance with sections 2.2.14.4.22 and 2.2.16.2.1 of RTCA Document DO-181B (EUROCAE ED-73A, sections 3.18.4.27 and 3.20.2.1).

Note: *In ADS-B messages (those transmitted with downlink format DF=17 or DF=18) both the "CL" = 0 and "IC" = 0. In other words, in ADS-B messages, the parity is overlaid with a 24-bit pattern of ALL ZEROs.*

2.2.3.2.2 DF=17 and 18 Format Structures

All DF=17 and 18 ADS-B transmissions have the baseline structure defined in section 2.2.3.2.1. The "ME" field is defined for each of the ADS-B message types in the following subparagraphs.

microsecond. An inferred leading edge is defined as an event in which a leading edge is assumed to exist in order to account for a pulse whose width implies the existence of overlapping pulses.

b. All performance requirements shall be met for pulses having the following characteristics:

(1). Pulse Amplitude Variation: up to +2 dB, relative to the amplitude of the first preamble pulse

(2). Pulse rise time: 0.1 microsecond or less

(3). Pulse decay time: 0.2 microseconds or less

2.2.4.3.4.7.2 Criteria for Preamble Acceptance

The first qualifying criterion for reception of an ADS-B 1090 MHz message signal shall be the reception of the Preamble (subparagraph 2.2.3.1.1). A preamble shall be accepted if each of the four pulse positions of the preamble waveform contains a pulse that is above the receiver threshold for at least 75 percent of its nominal duration, ***AND*** the last three pulses are within $\pm$0.125 microseconds of their nominal position relative to the first pulse, ***AND*** at least two of the four preamble pulses have actual leading edges (as defined in subparagraph 2.2.4.3.4.7.1.a) that occur within $\pm$0.125 microseconds of their nominal edge positions. All inferred leading edges shall occur within $\pm$0.125 microseconds of the expected nominal position.

Note: *Appendix "I" provides description of an improved implementation.*

2.2.4.3.4.7.3 Criteria for Data Block Acceptance in ADS-B Message Signals

ADS-B Messages always contain 112 data bits. Each bit of the 1090 MHz ADS-B Message Data Block shall be decoded by comparing the received signal with a 0.5 microsecond delayed replica of itself to determine the difference between the signal amplitudes at the centers of the two possible pulse positions for that bit.

The ADS-B transmission shall be accepted as a valid ADS-B Message if:

a. The first five bits of the data block contain either the code 1 0001, 1 0010 or 1 0011 (i.e., either DF=17, DF=18 or DF=19);

b. ***AND*** no error is detected, ***OR*** error correction performed in accordance with section 2.2.4.4.2.2.d and Appendix A, Section 3 of RTCA Document No. DO-185A can be successfully applied, ***AND*** no more than seven consecutive data bits fail the following confidence test:

Sample the received signal at least eight times during the one microsecond bit interval to determine if the amplitude of the received signal is above or below the dynamic minimum triggering level of the receiver. The data bit shall be declared a high-confidence bit if, between the first and second of the two possible pulse positions for that bit, the difference in the number of samples for which the signal is above DMTL is at least three ***AND*** the sign of this difference agrees with the decoded value of the bit.